

4π Off-axis Deployment Procedure

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1 Verification of Initial Conditions

1. All tubes are hanging on the storage rack in the glovebox in the proper order (segment 1 will be removed first).
2. The pre-deployment nitrogen purge procedure has been performed, leaving the 6" gate valve open and the 16" gate valve closed.
3. The calibration source, attached to a specialized BTC segment, is in the glovebox. The Cotter pins that secure it in place are firmly attached.
4. The in-pole source pins are in place in the appropriate segments.
5. Both control cables are fully retracted inside the glovebox, and the spools appear free to turn without obstruction.
6. The Clevis pins and shoulder bolts at the cable attachment points are secured. The screws that join the two sides of the cable clamp are tight.
7. The cable 2 instrumentation unit is secured inside the cable 2 attachment segment, with its electrical cable connected. The operator verifies that the readout is functioning properly.
8. The pin block is firmly attached to the Conflat flange on the bottom of the glovebox, with the spring pin in place.

2 Assembly of source, first pole segment, and cable 2 attachment

1. Initially, cable 1 is retracted as far as practical, and extra slack is put in cable 2 so that it can be placed out of the way on the floor of the glovebox.

2. The source, attached to a BTC, is placed in the pin block by the lower operator.
3. The upper operator lifts pole segment 1 from the rack and holds it from the top as the lower operator takes it at the bottom and holds it there, with the engraved segment number facing towards the lower operator.
4. The upper operator attaches the top cable attachment (“hoist”) segment to the top of the new segment. Both the internal safety line and the BTC coupling are attached.
5. The new segment is positioned with the manual motor controller so that the lower operator can attach it to the source. It is first lifted so that the internal safety line can be attached, then lowered to make the BTC connection. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
6. The detector PMT high voltage is turned off.
7. The 16” gate valve is opened.
8. The upper operator uses the manual motor controller to lower the hoist segment while the lower operator turns the source piece appropriately to pass it through the pin block.
9. The new segment is lowered, with a careful eye to be sure that the ring attached to the in-pole source clears, until its pins rest in the pin block.
10. The hoist segment is detached by the lower operator.
11. The hoist segment is raised back to its retracted position.
12. The lower operator joins the cable 2 attachment segment to the pole segment in the pin block, ensuring that the cable clamp is pointing up. Both the internal safety line and the BTC coupling are attached. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
13. The cable 2 attachment segment is lowered until its upper pins rest in the pin block.
14. Pole segment 2 is attached to the cable 2 attachment segment. Primarily because of the position of the limit switch, it is not possible to make this connection using the hoist. Instead, the upper operator holds pole segment 2 from the top as the lower operator attaches it. The engraved segment number should face towards the lower operator. Both the internal safety line and the BTC coupling are attached. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
15. The pole is lifted up approximately 5 cm by cable 2, so that the pins on the pole clear the side pins on the pin block.
16. The pin block is turned out of the way by the lower operator, and the pole is lowered by cable 2 until it is possible to attach the hoist segment.

17. The lower operator re-closes the pin block and locks it with the spring pin.
18. The hoist segment is attached to pole segment 2 by the upper operator. Both the internal safety line and the BTC coupling are attached.
19. Cable 2 is lowered by 20 cm to introduce slack as future segments are lowered by both cables simultaneously.
20. Both cables are lowered simultaneously until the pins of segment 2 rest in the pin block.
21. The lower operator disconnects the hoist segment.
22. The hoist segment is raised back to its retracted position.

3 Assembly of additional pole segments

The following steps are repeated an appropriate number of times to build up a pole of the desired number of segments.

1. The upper operator lifts the next pole segment from the rack and holds it from the top as the lower operator attaches it at the bottom. The engraved segment number should face the lower operator. Both the internal safety line and the BTC coupling are attached. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
2. The upper operator attaches the hoist segment to the top of the new segment. Both the internal safety line and the BTC coupling are attached.
3. The manual motor controller is used to lower both cables simultaneously by about 20 cm, as the lower operator turns the pole to guide the pins through the pin block.
4. The new segment is lowered, again with both cables moving simultaneously, until its pins rest in the pin block.
5. The hoist segment is disconnected from the new segment and retracted.

4 Assembly of final segment

1. The lower operator attaches the cable 1 instrumentation unit segment to the pole. Both the internal safety line and the BTC coupling are attached. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
2. The hoist cable is lowered so that it can be attached to the cable 1 instrumentation unit attachment segment. Both the internal safety line and the BTC coupling are attached. The coupling is tightened first by hand and then with the wrench provided in the glovebox.
3. The instrumentation unit connector is attached. At this point, the correct readout of both instrumentation units is verified.

5 Tare

1. The upper cable attachment piece is lowered until its pins are in the pin block.
2. Cable 1 is raised until it just barely picks up the pole from the pin block. The lower operator feels this point by hand.
3. Cable 2 is raised until it just barely picks up the pole from the pin block.
4. The “Menu Recall” key on the manual control panel is used to place it in a mode where an inadvertant keypress will not do anything. A “computer control in use” sign is placed over the control panel.
5. The computer control program is launched.
6. The settings in the “Pole Geometry...” dialog are set to values corresponding to the number of segments in the pole. A table of these values will be provided here.
7. The settings in the “Limits/tolerances...” dialog are checked.
8. The control program tare function is used, with cable 1 length set to 0 and cable 2 length equal to the length of the pole from one cable clamp to the other. (These lengths are presented as a default.)
9. From this point on, the computer control program is used exclusively, until the pole has been re-secured in the pin block following the deployment.

6 Start of deployment and attachment of pivot block

1. The cable speed is set to 2 motor revolutions per second.
2. Cable 2 is lowered by 10 cm to provide some slack.
3. Both cables are raised by 6 cm.
4. The pin block is rotated out of the way.
5. Both cables are lowered simultaneously by six 10 cm steps while the operator guides the pole attachment through the pin block.
6. The pin block is closed, and the cable guide piece is installed over the pin block.
7. Both cables are lowered by an appropriate distance to reach the appropriate pivot block position, given in the table of dimensions for the pole geometry. It is necessary to move in steps of no more than about 10 cm, a requirement that is enforced by the control program.
8. The source pin in the pivot block is checked for secure attachment.

9. The locking screw for the pivot block cable clamp is loosened, as is the clamp screw.
10. The clamp side of the pivot block is slid over cable 1, and the clamp screw is tightened firmly but not excessively. The locking screw is tightened.
11. The security of the pivot block is verified by gently attempting to move it along the cable.
12. The open side of the pivot block is placed onto cable 2, attached to the clamp side, and locked.
13. The cable guide piece is removed, the pin block is rotated out of the way, and cable 2 is moved out of its cable slot in the pin block.
14. Both cables are lowered by three 10 cm steps while the lower operator guides the pivot block through the pin block.
15. Cable 2 is moved back into its cable slot in the pin block, the pin block is closed, and the cable guide piece is installed over the pin block.

7 Movement to center of detector

1. Both cables are lowered until the center of the pole is in the center of the detector, taking 10 cm steps until the pivot block has cleared the flange stack and detector neck. Beyond that point, 1 m steps are authorized. [In the height-constrained LBL high bay test area, the cables are simply lowered by 100 cm.]
2. When it is desired to rotate the pole, the cable speed is reduced to 1 motor revolution per second.

8 Calibration

1. The light covers are placed over the penthouse and the main glovebox windows.
2. The detector PMT high voltage is turned on.
3. Calibration data are taken. The optimal set of calibration positions is a subject of continuing discussion.

9 Retraction from detector

1. The detector PMT high voltage is turned off.
2. The light covers are removed from the penthouse and the glovebox.

3. Both cables are raised or lowered together until the center of the pole is near the center of the detector.
4. Cable 2 is lowered until the pole is vertical, with 10 cm of slack in cable 2.
5. The pole is raised by both cables simultaneously until the pivot block is 20 cm below the pin block. At the relevant point where the pivot block approaches the sensitive region near the top of the detector, the control software will begin to enforce 10 cm steps.
6. The cable guide piece is removed, the pin block is rotated out of the way, and cable 2 is rotated out of its cable slot in the pin block.
7. Both cables are raised in 10 cm increments until the pivot block is clear of the pin block.
8. Cable 2 is rotated back into the cable slot, the pin block is closed, and the cable guide piece is re-attached.
9. The locking screw on the pivot block is loosened, then the clamp screw. The pivot block is removed from cable 1.
10. The open side of the pivot block is pulled apart and removed from cable 2.
11. Both cables are raised until the indicated cable 1 length is 75 cm, where the top of the pole is 10 to 20 cm below the pin block.
12. The cable guide piece is removed and the pin block is rotated out of the way.
13. Both cables are raised until the pins of the cable 1 instrumentation unit attachment segment are above the pin block.
14. The pin block is closed and locked with the spring pin.
15. The computer control program is stopped, and the "computer control in use" sign is removed from the manual control panel. From this point on, the manual controller is used exclusively.
16. Using the manual motor controller, both cables are lowered to place the pins of the top segment into the pin block.

10 Disassembly of final pole segment

1. The instrumentation unit is electrically disconnected.
2. The hoist is disconnected from the instrumentation unit 1 segment.
3. The instrumentation unit segment is disconnected from the top pole segment and placed to the side in the glovebox.

11 Disassembly of pole segments

The following steps are repeated to remove all segments that were attached after segment 2. (Following this section, the remaining pole will include segments 1 and 2 along with the cable 2 attachment piece and the source itself.)

1. The hoist segment is lowered, and the lower operator connects it to the pole segment in the pin block. Both the internal safety line and the BTC coupling are attached.
2. Both cables are raised by 6 cm so that the pins are above the pin block, and the pin block is opened.
3. Both cables are raised until there is visual contact with the next set of pins.
4. The lower operator holds the pole to guide it as the pins are raised through the pin block (to approximately 6 cm above it).
5. The pin block is closed and locked with a spring pin.
6. Both cables are lowered until the pins rest in the pin block.
7. The lower operator unscrews the BTC holding the segment in the pin block to the one above it.
8. The hoist cable is raised slightly, and the lower operator disconnects the internal safety line from the segment in the pin block.
9. The upper operator disconnects the hoist from the pole segment and places the pole segment back into the rack.

12 Disassembly of source, first pole segment, and cable 2 attachment

1. The hoist segment is lowered, and the lower operator connects it to pole segment 2, which is in the pin block. Both the internal safety line and the BTC coupling are attached.
2. Both cables are raised by 6 cm so that the pins are above the pin block, and the pin block is opened.
3. Both cables are raised until the hoist has reached the top of its range of travel.
4. Cable 2 is raised until it bears the weight of the pole.
5. The upper operator disconnects the hoist from the pole segment.
6. Cable 2 is raised until the pins of the cable 2 attachment piece are 6 cm above the pin block.

7. The pin block is closed and locked with a spring pin.
8. Cable 2 is lowered until the pins of the cable 2 attachment segment rest in the pin block.
9. The lower operator disconnects pole segment 2 from the cable 2 attachment segment and hands it to the upper operator, who places it back into the rack.
10. Cable 2 is raised until the pins of the cable 2 attachment piece are 6 cm above the pin block, and the pin block is opened.
11. Cable 2 is raised until the pins of pole segment 1 are 6 cm above the pin block.
12. The pin block is closed and locked with a spring pin.
13. Cable 2 is lowered until the pins of pole segment 1 rest in the pin block.
14. The cable 2 attachment segment is disconnected from pole segment 1 and placed to the side in the glovebox.
15. The hoist segment is lowered, and the lower operator connects it to the pole segment in the pin block. Both the internal safety line and the BTC coupling are attached.
16. The hoist is raised by 6 cm so that the pins are above the pin block, and the pin block is opened.
17. Both cables are raised until there is visual contact with the next set of pins (on the source).
18. The lower operator holds the pole segment to guide it as the pins are raised through the pin block (to approximately 6 cm above it).
19. The pin block is closed and locked with a spring pin.
20. Both cables are lowered until the pins of the source rest in the pin block.
21. The lower operator unscrews the BTC holding the source to pole segment 1.
22. The hoist cable is raised slightly, and the lower operator disconnects the internal safety line from the segment in the pin block.
23. The upper operator disconnects the hoist from the pole segment and places pole segment 1 back into the rack.
24. The 16" gate valve is closed.
25. The source, connected to a BTC, is removed from the pin block and placed to the side in the glovebox.
26. The 6" gate valve is closed.